an aluminum-copper-titanium alloy layer, wherein the aluminum-copper-titanium alloy layer comprises less than 0.57 atomic percent titanium, about 0.5 atomic percent copper and the remainder is aluminum;

C3 Concl'd

a second titanium layer; and

a second titanium nitride layer.

REMARKS

Claims 4-6, 9-11, 14-16 and 19-21 were examined. Claims 4, 5, 9, 10 and 14-16 are requested to be amended. Claims 4-6, 9-11, 14-16 and 19-21 remain in the application. These claims have been amended to put them in better condition for allowance and to narrow the issues on appeal. Applicants further believe that the claims as amended should have been encompassed in the earlier search conducted by the Patent Office and, therefore, no further search is necessary. Applicants respectfully request that the Patent Office enter the claims amendments as presented.

I. Claims Rejected Under 35 U.S.C. §103(a)

The Patent Office rejects claims 4-6, 9-11, 14-16, and 19-21 under 35 U.S.C. §103(a) as obvious over U.S. Patent No. 5,635,763 issued to Inoue et al. (Inoue) in view of U.S. Patent No. 4,999,160 issued to Lowrey et al. (Lowrey). Inoue is cited for disclosing a semiconductor device comprising a multilayered interconnection structure comprising an aluminum alloy layer between nitride and titanium nitride layers. Lowrey is cited for purportedly disclosing an aluminum-copper-titanium alloy layer as an interconnection containing 0.5-3 weight percent copper, 0.05-1 weight percent titanium, and 0.5-2 weight percent silicon.

As noted in the previous Response to Office Action, Inoue describes a multilayered interconnection structure focusing on electromigration performance and stress migration performance. Inoue describes an aluminum alloy as part of that interconnection. Examples for the aluminum alloy includes Al-Cu, Al-Si, and Al-Ti.

Lowrey describes an aluminum alloy structure of Al-Cu-Si-Ti. Thus, Lowrey describes an aluminum-silicon alloy. Lowrey notes advantages of aluminum-silicon alloy as that is inexpensive, easy to etch, and a relatively good conductor. Column 1, lines 16-18. Lowrey does not describe an aluminum-copper-titanium alloy.

Applicants' application evaluated various aluminum alloys. See pages 11-12 and Figure 7. As illustrated in Figure 7, the most striking result regarding the electromigration lifetime was seen in the aluminum-copper-titanium (Al-Cu-Ti) alloy. As illustrated by Table 1 (page 11) and Figure 7, the electromigration lifetime of the Al-Cu-Ti alloy was multiplicative rather than additive. As one of skill in the art might expect given the known properties of Al-Ti and Al-Cu alloys.

Independent claim 4, as amended, is prima facie not obvious over the cited references, because the cited references do not describe an Al-Cu-Ti alloy containing less than 0.57 atomic percent titanium, about 0.5 atomic percent copper and the remainder aluminum. Lowrey describes an Al-Cu-Si-Ti alloy. Lowrey does not describe an Al-Cu-Ti alloy. Based on the differing properties of various alloys such as illustrated in the Application at pages 11-13 and Figure 7, one cannot assume that all aluminum alloys behave similarly and thus that it would have been obvious to remove the silicon from the alloy of Lowrey. To the contrary, Lowrey teaches an Al-Si alloy. Specifically, Lowrey teaches an Al-Si alloy where the optimum amount of Si is the saturation concentration of Si in Al and the acceptable range is 0.5 to 2.0 percent by weight of the alloy. Thus, Lowrey teaches away from the present invention as the independent claim 4 does not state an alloy having Si within the range that Lowrey defines as acceptable. Lowrey offers no substitute for silicon or examples where silicon is not included. Accordingly, reconsideration and withdrawal of the obviousness rejection of claim 4 are requested.

For the above stated reasons, independent claim 4 is not obvious over the cited references. Claims 5 and 6 depend from claim 4 and therefore contain all the limitations of that claim. For the reasons stated with respect to claim 4, claims 5 and 6 are not obvious over the cited

references. Accordingly, reconsideration and withdrawal of obviousness rejection of claims 5 and 6 are requested.

Independent claim 9 is similar to independent claim 4 in that it describes an interconnection of Al-Cu-Ti alloy containing less than 0.57 atomic percent titanium, about .5 atomic percent copper and the remainder aluminum. Thus, for the reasons stated with respect to independent claim 4, independent claim 9 is not obvious over the cited references. Accordingly, reconsideration and withdrawal of the obviousness rejection of claim 9 are requested.

Claims 10 and 11 depend from claim 9 and therefore contain all the limitations of that claim. For the reasons stated with respect to claim 9, claims 10 and 11 are not obvious over the cited references. Accordingly, reconsideration and withdrawal of the obviousness rejection of claim 9 are requested. Accordingly, reconsideration and withdrawal of the obviousness rejection of claims 10 and 11 are requested.

Independent claim 14 relates to an integrated circuit comprising a substrate and an interconnection level. The interconnection level comprises an Al-Cu-Ti alloy containing less than 0.57 atomic percent titanium, about 0.5 atomic percent copper and the remainder aluminum. In this regard, the arguments presented above with respect to independent claims 4-6 may be used to distinguish independent claims 14 and dependent claim 15 from the cited references. Accordingly, reconsideration and withdrawal of the obviousness rejection of claims 14 and 16 are requested.

Independent claim 16 relates to a multi-layered interconnection structure formed on a substrate. A portion of that interconnection layer comprises an Al-Cu-Ti alloy containing less than 0.57 atomic percent titanium, about 0.5 atomic percent copper and the remainder aluminum. Thus, the arguments distinguishing claims 4-6 may be used to distinguish claims 16 and its dependent claims 19-21.

Accordingly, reconsideration and withdrawal of the obviousness rejection of claims 16 and 19-21 are requested.

CONCLUSION

In view of the foregoing, it is believed that all claims now pending, as amended, namely claims 4-6, 9-11, 14-16 and 19-21, patentably define the subject invention over the prior art of record and are in condition for allowance and such action is earnestly solicited at the earliest possible date. If the Examiner believes that a telephone conference would be useful in moving the application forward to allowance, the Examiner is encouraged to contact the undersigned at (310) 207-3800.

Respectfully submitted,

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Dated: November 13, 2001.

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CERTIFICATE OF MAILING:

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: Assistant Commissioner for Patents, Washington, D.C. 20231 on November 13, 2001.

Lillian Rodriguez 11-13-01

Lillian Rodriguez November 13, 2001

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS

4. (Amended) An interconnection comprising:

an aluminum copper titanium alloy layer, wherein the aluminum-copper-titanium alloy layer [contains] comprises [about 0.1] less than 0.57 atomic percent titanium, about 0.5 atomic percent copper and the remainder is aluminum.

5. (Amended) The interconnection of claim 4, wherein the aluminum-copper-titanium alloy layer comprises [about 0.5 atomic percent copper and] about 0.1 atomic percent titanium.

9. (Amended) An interconnection formed on a substrate of an integrated circuit comprising an aluminum-copper-titanium alloy layer, wherein the aluminum-copper-titanium alloy layer [contains] comprises [0.1] less than 0.57 atomic percent titanium, about 0.5 atomic percent copper and the remainder is aluminum.

10. (Amended) The interconnection of claim 9, wherein the aluminum-copper-titanium alloy layer contains [about 0.5% atomic percent copper and] about 0.1 atomic percent titanium.

14. (Amended) An integrated circuit comprising:

a substrate; and

an interconnection level disposed about the substrate, the interconnection level having an aluminum-copper-titanium alloy layer, wherein the aluminum-copper-titanium alloy layer [contains] comprises [0.1] less than 0.57 atomic percent titanium, about 0.5 atomic percent copper and the remainder is aluminum.

15. (Amended) The integrated circuit of claim 14, wherein the aluminum-copper-titanium alloy layer contains [about 0.5% atomic percent copper and] about 0.1 atomic percent titanium.

16. (Amended) A multilayered interconnection structure formed on a substrate, the interconnection comprising:

a first titanium layer;

a first titanium nitride layer;

an aluminum-copper-titanium alloy layer, wherein the aluminum-copper-titanium alloy layer [contains] comprises [0.1] less than 0.57 atomic percent titanium, about 0.5 atomic percent copper and the remainder is aluminum;

a second titanium layer; and

a second titanium nitride layer.